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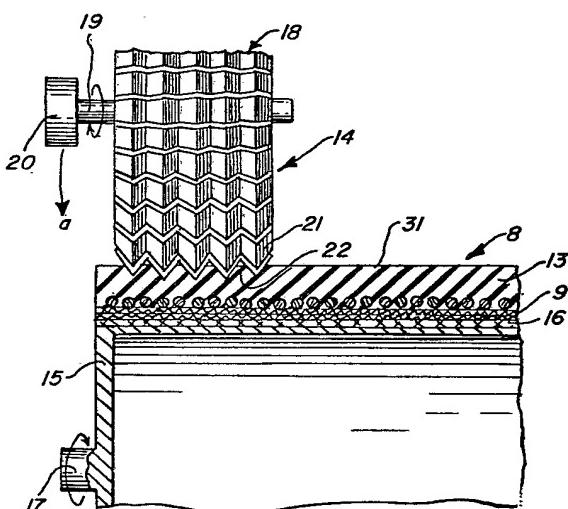
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㉒ Method of making a ribbed belt.

㉓ In order to overcome drawbacks known in methods of making prior ribbed belts, these drawbacks concerning the accuracy of the V-grooves, sticky adhesion of rubber in proportion to the generation of heat, dimensional instability after vulcanisation, etc., the present invention provides a method of making a ribbed belt having a plurality of longitudinally extending ribs wherein a vulcanized belt sleeve (8) is put into one mandrel (15) or said belt sleeve laid over two mandrels and cut with a milling attachment (14) combining multiple double angle milling cutters in such a manner that the rotation of the milling attachment is opposed to that of the mandrel and the revolution speed of the milling attachment is greater than that of the mandrel, thus precisely defining a ribbed section of the belt in a simultaneous manner.



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DescriptionMETHOD OF MAKING A RIBBED BELT

This invention relates to power transmission belt manufacture and more particularly to a method of 5 making an endless power transmission ribbed belt. Such a ribbed belt is thin and flexible compared with ordinary V-belts, and is excellent in high-speed rotation and its ability to transmit power. Such ribbed belts are, therefore, widely used in drive devices of automobiles wherein the power transmission belt is arranged 10 in a serpentine path about the crank pulley, alternator pulley, a cooler pulley, etc.

A method (1) of forming a belt using a tubular matrix is disclosed in U.S. Letters Patents Nos. 15 3,839,116 and 3,981,206. The method disclosed therein comprises building up successively a lower fabric, a lower rubber layer, a tensile member, an upper rubber layer, and an upper fabric, on a tubular matrix having 20 a plurality of V-grooves in a circumferential direction inserted into a cylindrical drum, to form a vulcanized belt sleeve having a plurality of V-grooves. The belt sleeve is then cut into individual belts.

Another method (2) of forming a belt using a grinding wheel is disclosed in U.S. Letters Patents Nos. 25 3,818,576, 3,822,516 and 4,177,688, in which the vulcanized belt sleeve is formed on a mandrel and ground with a contoured grinding wheel to precisely define the desired plurality of longitudinally extending ribs.

Another method (3) of forming a belt is using 30 a Rotocure mechanism as disclosed in U.S. Letters Patent No. 4,139,406, in which a formed belt sleeve is laid

over the Rotocure mechanism having a plurality of V-grooves to define the desired ribbed section belt.

A casting method (4) of forming a belt is disclosed in U.S. Letters Patent No. 3,813,197 and 5 Great Britain Patent No. 1,123,225, which comprises the fixing of an inner mold having a fabric and a tensile member wound thereon, in an outer mold having a plurality of V-grooves arranged circumferentially along its inner surface, casting urethane elastomeric material in 10 the mold cavity to form a belt sleeve, and cutting the belt sleeve into the desired final belts.

In carrying out methods (1), (2) and (3), the method using a grinding wheel (2) and the method using Rotocure (3), the ribbed belts may be made of an ordinary rubber, such as NR, SBR, CR, etc. In method (1), 15 the use of a flat lower rubber layer on the tubular matrix is disadvantageous in that the tensile members may fall into the V-grooves of the tubular matrix during vulcanization and thus become arranged randomly, which 20 may result in an undesirable stretchable belt. However, the use of a ribbed lower rubber layer prevents such defects, and the manufacture of the belts is facilitated and improved. Another serious disadvantage in method (1) lies in the difficulty of removing the formed belt 25 sleeve from the tubular matrix which conventionally causes a short lift of the tubular matrix.

In method (2), the surface temperature of the vulcanized belt sleeve reaches more than 100°C. during the grinding process so that reversion, due to a break 30 in the intermolecular bonds, occurs on the surface of the sleeve. This may produce troublesome sticky adhesion. Also, since the yieldable belt sleeve is deformed by the grinding wheel during the grinding operation, it is difficult to grind the V-grooves accurately. The

material and roughness of the grinding wheel must be correlated with the hardness of the belt sleeve.

A problem arises in the method (3) manufacture in that the belt sleeve shrinks when it is removed from
5 the heated Rotocure mechanism. The thermal efficiency of the process is therefore very low because the Roto-
cure mechanism must be cooled before the belt sleeve is removed necessitating repeating heating and cooling steps.

10 The above mentioned methods, which have been developed for making ribbed belts, have drawbacks concerning the accuracy of the V-grooves, sticky adhesion of rubber in proportion to the generation of heat, dimensional instability after vulcanization, high cost,
15 etc.

The present invention provides an improved belt manufacture eliminating the disadvantages of the background art methods discussed above in a novel and simple manner.

20 An object of the invention is to provide a method of making a ribbed belt in which the V-grooves of the ribbed belt are accurately formed.

Another object of the invention is to provide such a method of making a ribbed belt in which the cutting of the V-grooves is effected in such a manner as to
25 prevent sticky adhesion of the vulcanized belt sleeve.

The improved belt manufacture method of the present invention comprises the steps of placing a vulcanized belt sleeve in a mandrel, rotating the mandrel,
30 and operatively associating a milling attachment having multiple double angle milling cutters with the rotating belt sleeve, the rotation of the milling attachment being opposed to that of the mandrel and the revolution speed of the milling attachment being larger than that

of the mandrel, thus to accurately cut V-grooves into the belt sleeve, and to cut the belt sleeve produced in this manner into the desired belts.

5 This invention will be described in detail with reference to the accompanying drawings wherein:

Figure 1 is a transverse section, with parts cut away, showing a ribbed belt formed by a manufacturing process embodying the invention;

10 Figure 2 is a fragmentary section showing a first step in the method of forming the vulcanized belt sleeve;

Figure 3 is a fragmentary sectional view illustrating the method of cutting the V-grooves in the sleeve in one form of the invention;

15 Figure 4 is an elevation of a double angle milling cutter tool for cutting the sleeve;

Figure 5 is a fragmentary sectional view taken along line 5-5 of Figure 4;

20 Figure 6 is a fragmentary sectional view illustrating the arrangement of the cutter tool at the completion of the cutting operation;

25 Figure 7 is a fragmentary sectional view illustrating the method of manufacture of another exemplary embodiment of a ribbed belt in accordance with the invention;

Figure 8 is a cross section of a ribbed belt made by the method of Figure 7; and

30 Figure 9 is a side elevation showing a step in the method of manufacturing a long ribbed belt in accordance with the invention.

Reference is now made to Fig. 1 of the drawing which illustrates one exemplary embodiment of a ribbed belt, generally designated 1, manufactured by the improved process of the invention. Ribbed belt 1 is

made primarily of elastomeric material and comprises an upper rubber layer 2, a ropelike tensile member 3 made of, for instance, polyester fibers or aromatic polyamide fibers high in strength and low in elongation,
5 and a ribbed section 4 defined by a plurality of longitudinally extending V-grooves 5 and ribs 6 having a triangular cross section configuration. As shown, upper rubber layer 2 of belt 1 may be provided with an outer fabric cover layer 7.

10 Belt 1 is formed from a sleeve 8. The manufacture of sleeve 8 is illustrated in Fig. 2.

As shown, a stretchable fabric 9 is wound onto a cylindrical drum 10 in one or more plies. Fabric 9 comprises a bias fabric having high stretchability, and may illustratively have warps and wefts forming a cross angle of 90 to 155 degrees. A lower rubber layer 11 is wound on the fabric 9. Thereafter, a ropelike tension member 12 made of, for instance, polyester fibers high in strength and low in elongation
15 and covered with a cushioning rubber layer, is spirally wound onto lower rubber layer 11. The thickness of upper rubber layer 13 is preferably greater than that of lower rubber layer 11. Upper rubber layer 13 is laminated on the layer of the tensile member 12 and the
20 assembly thus obtained is vulcanized in accordance with techniques well known in the art to form the completed belt sleeve 8.

The vulcanized belt sleeve is removed from the drum 10 and placed on an expandable mandrel 15.
30 The belt sleeve is then cut by means of a milling attachment 14. The rotating milling attachment 14 cuts the rotating belt sleeve 8 in a novel manner to provide an improved highly accurate ribbed configuration.

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As shown, belt sleeve 8 is placed on mandrel 15 so that upper rubber layer 13 defines the radially outer surface 31 of the belt sleeve. Prior to placing the belt sleeve on the mandrel, an expandable tubular member 16 may be mounted concentrically around the mandrel and preferably held in position by the frictional engagement of its inner surface with the outer surface of the mandrel. The expandable tubular member 16 is desirable in preventing damage to the cutter blades in the finishing process. Tubular member 16 illustratively may be formed of an inexpensive elastomeric material.

Mandrel 15 is then rotated in the indicated arrow direction by a suitable drive (not shown) connected to a drive shaft 17 of the mandrel.

Milling attachment 14 includes a plurality of double angle milling cutters 18 carried on a drive shaft generally designated 19, and a drive means 20 for driving drive shaft 19 in an opposite direction of rotation as indicated by the arrow in Fig. 3. The number of double angle milling cutters 18 mounted on drive shaft 19 is determined by the number of V-grooves desired in the ribbed belt. The surface configuration of the milling attachment comprises V-shaped protrusions 21 and V-shaped grooves 22 corresponding to the configuration of ribbed section 4 of belt 1.

Each double angle milling cutter 18, as shown in Figs. 4 and 5, is defined by a circular body section 33 and a plurality of cutting edges 30 regularly arranged about its circumference. The depth (d) of cutter edge 30 is almost equal to that of the ribs in the belt. Cutting edge 30, as shown, has a triangular cross section configuration. The double angle milling attachment 14 must be rotated in the direction desig-

nated by an arrow, in such a manner that precise V-grooves are cut into the outer surface 31 of the belt sleeve 8.

By causing the attachment 14 and mandrel 15 to be rotated in opposite directions, it is possible to cut precise accurate V-grooves as a result of the double angle milling cutters pushing into the belt sleeve, while at the same time, the life of the cutting edge is effectively maximized.

In effecting the cutting of the V-grooves in the belt section 13, the rotating milling attachment 14 is slowly moved toward the rotating mandrel 15, namely, in the arrow direction (a) shown in Fig. 3, by a translating means 20 to urge the cutter into one end portion of the belt sleeve 8 whereupon the desired V-grooves are accurately cut into the outer surface 31 of the belt sleeve. In order to form the desired triangular ribs 6, the double angle milling cutters 18 are pushed into the belt sleeve until the top of the V-shaped grooves 22 thereof are disposed at the outer surface 31 of the belt sleeve.

The cutting speed of milling attachment 14 is preferably greater than the revolution speed of the surface 31 and preferably is from 30 to 130 times the surface speed in order to provide the V-grooves of the belt with a proper rough surface. At a ratio of less than approximately 30 to 1, the surfaces of the V-grooves are excessively rough, and the cutting step is inefficiently time consuming. On the other hand, at a ratio of more than 130 to 1, the V-groove surface of the belt is undesirably smooth so that the belt is liable to slip in use because of the coefficient of friction.

The desirable ratio of feed of milling attachment 14 radially toward mandrel 15 is a function of the

hardness of the belt sleeve. More specifically, since each of the double angle milling cutters 18 is concurrently engaging upper rubber layer 13 in the cutting operation, there is a tendency for upper rubber layer 13
5 to deform.

- The upper and lower layers 13 and 16 may be made of a suitable elastomeric material, such as NR, SBR, rubber compound obtained by mixing short fibers in the above described rubber, polyurethane resin, etc.
10 The hardness (shore-A) of the elastomeric material is preferably from approximately 75° to 90°. The feed velocity of milling attachment 14 cutters into the belt sleeve outer layer is preferably approximately 2 to 10 mm/min.
15 If the feed velocity of the milling attachment is greater than 10 mm/min., it is difficult to cut the V-grooves precisely because of the resultant deformation of the belt sleeve. The milling attachment may be moved into the belt sleeve at a constant speed or inter-
20 mittently, as desired.

Fig. 6 shows the arrangement of the apparatus at the end of the cutting step. The milling cutters have been urged deeply into the belt sleeve to a position near tensile member 12 whereby precise V-grooves
25 are cut into the outer layer of the belt sleeve.

The milling attachment 14 is then moved by translating means 20 away from mandrel 15 in the arrow direction (b) shown in Fig. 6, to space the cutters from the sleeve belt.

30 The milling attachment 14 may now be moved by means 20 in the direction of the arrow (c), i.e., parallel to the drive shaft 17 into alignment with belt sleeve portion A to permit V-grooves to be cut in the portion A in a manner similar to that discussed above.

As will be obvious to those skilled in the art, milling attachment 14 may be moved automatically in a preselected manner to provide the cut belt.

The belt sleeve having the plurality of V-grooves is then suitably cut into discrete annular ribbed belts by a conventional cutting machine, as well known in the art.

Fig. 7 illustrates a modified method embodying the invention for manufacturing another exemplary embodiment of ribbed belt 23 illustrated in Fig. 8. Belt 23 is flat across the top 29 of the ribbed section 27. Ribbed belt 23, as shown in Fig. 8, comprises an outer fabric layer 24, an upper rubber layer 25, a tensile member 26, and a ribbed section 27. Section 27 is defined by a plurality of longitudinally extending ribs 28 each having a trapezoidal cross section. It will be seen that the thickness of the upper rubber layer 13, shown in Fig. 7, may be a fraction, such as half of that of the upper rubber layer 13 shown in Figs. 3 and 6.

The double angle milling cutters 18 are urged only partially into belt sleeve 8 so that the top 32 of the V-shaped groove 22 remains spaced from outer surface 31 of belt sleeve 8. Resultingly, ribbed section 27 defines a trapezoidal cross section configuration. The final manufacturing step in forming the belt 23 may be carried out as described above relative to belt 1.

Fig. 9 shows a modified step in the manufacture of a ribbed belt, advantageously adapted for use in making a long length ribbed belt. As shown, long belt sleeve 8 is entrained about both a driving mandrel 33 and a driven mandrel 34. The belt sleeve is stretched thereabout in order to prevent slip of the belt sleeve during the cutting operation. Driven mandrel 34 has flanges 35,36 on each side for preventing transverse

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shifting of the belt sleeve during the cutting step.
All other steps are similar to those described above.

Thus, in accordance with the disclosed invention,
the V-grooves of the ribbed belts are cut precisely
5 into the rib-forming section and have a pre-selected desired rough surface. The ribbed belts thusly manufactured have excellent power transmission characteristics and do not produce sticky adhesion as a result of generation of heat in use.

10 Thus, the method of belt manufacture of the present invention provides a significantly improved manufacture of such ribbed belts, overcoming the prior art problems incurred in the use of grinding wheels to form the belt grooves.

15 It is apparent that other modifications may be made without departing from the scope of this invention.

CLAIMS:

1. A method of manufacture of a drive belt having a plurality of longitudinal tapered ribs wherein a belt sleeve having an elastomeric drive surface portion is moved longitudinally through a cutting position, characterized by urging a plurality of V-shaped cutters into the drive surface portion of the moving belt sleeve while moving the cutters concurrently in a direction opposite the movement of the belt sleeve, the speed of movement of the cutters being substantially greater than the speed of movement of the drive surface portion.

2. The method of manufacture of a drive belt of claim 1 wherein the speed of movement of the cutters is in the range of 30 to 130 times the speed of movement of the drive surface portion.

3. The method of manufacture of a drive belt of claim 1 wherein the speed of movement of the cutters is in the range of 30 to 130 times the speed of movement of the drive surface portion and said cutters are urged into the drive surface portion at a rate of approximately 2 to 10 millimeters per minute.

4. The method of manufacture of a drive belt of claim 1, 2 or 3, wherein the width of the belt sleeve is at least twice that of the plurality of the cutters and the manufacture further includes removing the cutters from engagement with the belt sleeve upon completion of the formation of a first group of ribs and causing the plurality of cutters to form a second group of ribs adjacent the first group.

5. The method of manufacture of a drive belt of any preceding claim wherein said cutters are urged fully into said drive surface portion to define triangular ribs.

6. The method of manufacture of a drive belt of any one of claims 1 to 4 wherein said cutters are urged less than fully into said drive surface portion to define trapezoidal ribs.

7. The method of manufacture of a drive belt of any preceding claim wherein the direction of rotation of the milling attachment is opposed to the direction of rotation of said belt sleeve.

8. The method of manufacture of a drive belt of any preceding claim wherein the belt sleeve is placed on a mandrel and an expandable tubular member extends concentrically about said mandrel and is held in position thereon by frictional engagement of its inner surface with the outer surface of said mandrel, prior to placing said belt sleeve about said mandrel.

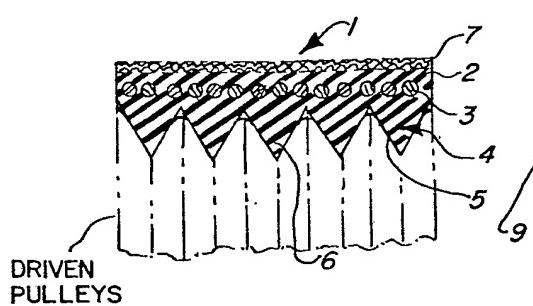
9. The method of manufacture of a drive belt of any preceding claim except claims 5 and 6 wherein said cutters are fed into said belt sleeve until the tops of the V-shaped grooves between the cutters are in a preselected spaced relationship to the outer surface of the belt sleeve to form a ribbed section having a substantially trapezoidal cross section configuration.

10. The method of manufacture of a drive belt of any preceding claim except claim 8 wherein said belt sleeve encircles a driving mandrel and a driven mandrel and said cutters engage said belt sleeve at said driven mandrel.

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FIG. 1



DRIVEN PULLEYS

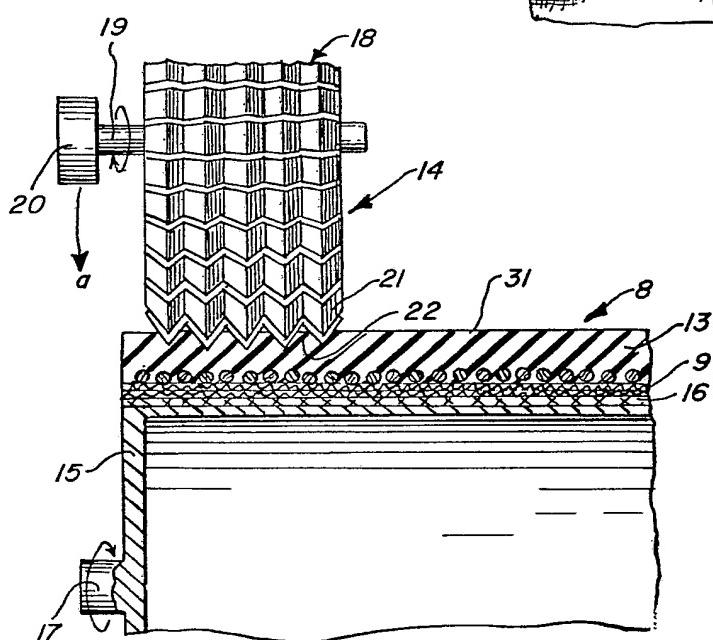


FIG. 2

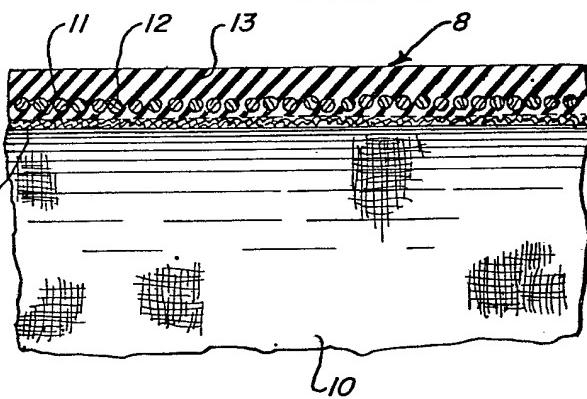


FIG. 3

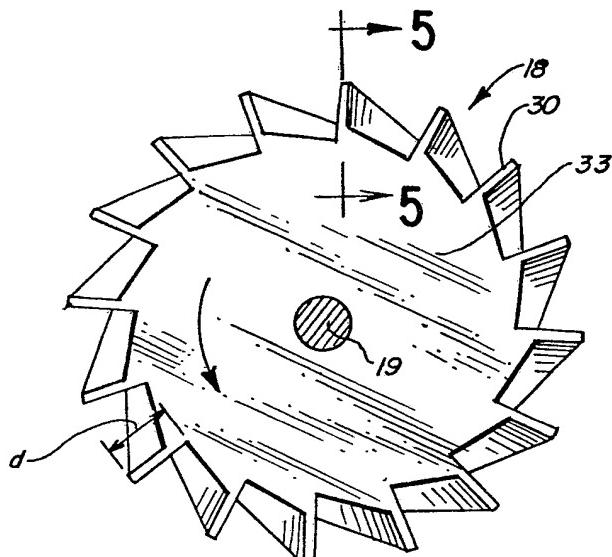
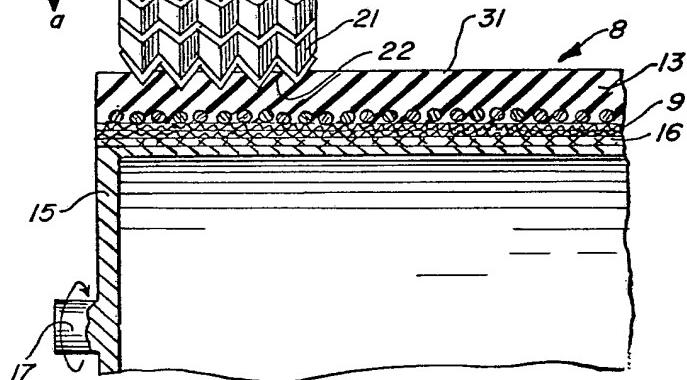


FIG. 4

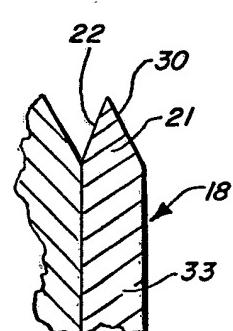


FIG. 5

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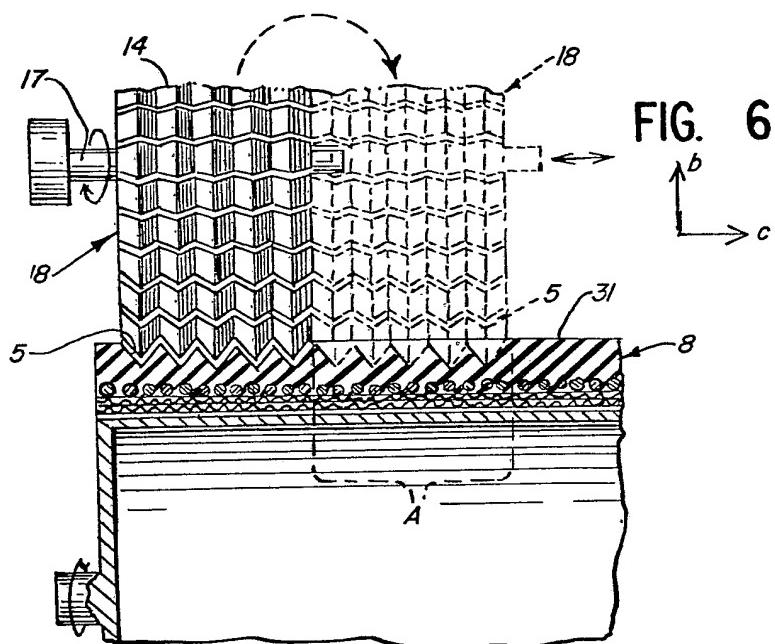


FIG. 6

b
c

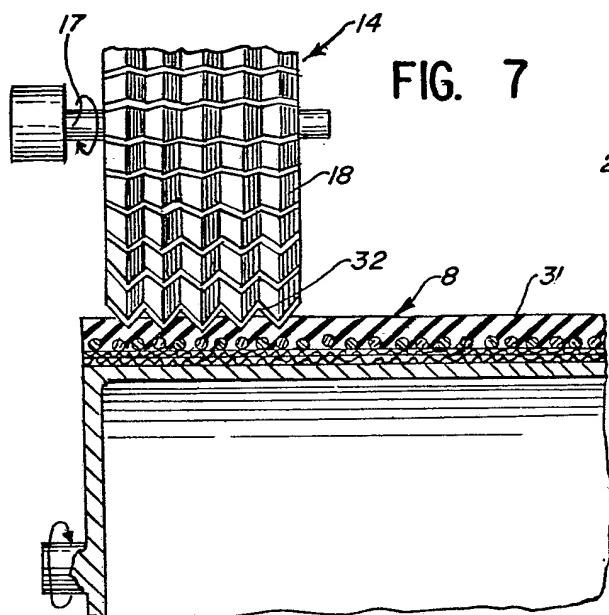


FIG. 7

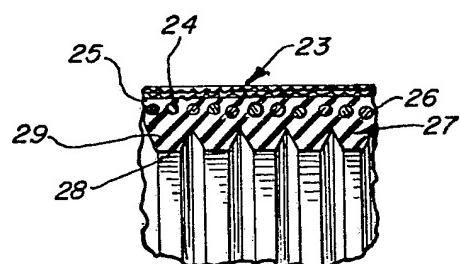


FIG. 8

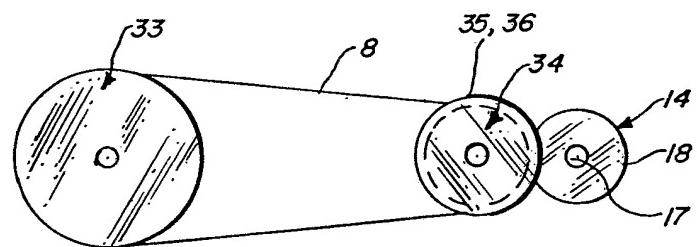


FIG. 9



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EUROPEAN SEARCH REPORT

0050173
Application number
EP 80 30 3717

| DOCUMENTS CONSIDERED TO BE RELEVANT | | | CLASSIFICATION OF THE APPLICATION (Int. Cl.) |
|---|--|-------------------|--|
| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | |
| D | <u>US - A - 3 818 576</u> (W. BRADEN) * Column 3, line 47 - column 4, line 15; column 4, line 52 - column 5, line 2 * | 1,2,6, 9 | B 29 H 7/22 |
| | --- | | |
| | <u>US - A - 3 891 405</u> (W. HUBER) * Column 2, lines 17-36; column 4, line 22 - column 5, line 20 * | 1,5,8 | |
| | --- | | |
| AD | <u>US - A - 4 177 688</u> (A. HOWERTON) | | |
| A | <u>US - A - 3 565 984</u> (H. SAUER) | | B 29 H 7/22 |
| A | <u>US - A - 3 477 895</u> (H. SAUER) | | |
| A | <u>US - A - 2 660 243</u> (E. LOMAZZO) | | |
| A | <u>US - A - 2 188 456</u> (H. GALBER) | | |
| | ----- | | |
| | | | CATEGORY OF CITED DOCUMENTS |
| | | | X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons |
| | | | &: member of the same patent family, corresponding document |
|  The present search report has been drawn up for all claims | | | |
| Place of search | Date of completion of the search | Examiner | |
| The Hague | 28-10-1981 | SCHMITT | |